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(54) Title: MULTIFUNCTIONAL COATED PRINTING SHEETS FOR USE IN ELECTROPHOTOGRAPHIC AND OFFSET PRINTERS

(57) Abstract: A multifunctional coated printing sheet suitable for use in color and monochromatic electrophotographic printers and in conventional offset printing presses. The multifunctional coated printing sheets exhibit runnability characteristics comparable to those of an uncoated printing sheet in most electrophotographic printers, provide the surface and optical properties required of conventional offset printing grades, and provide a surface that is image receptive and resistant to coating failure. The multifunctional coated printing sheet comprises a substrate and, on at least a first surface of the substrate, an image receptive coating including a binder and a non-platy pigment, the image receptive coating being substantially free of platy pigment. The present invention further provides a method of manufacturing such multifunctional coated printing sheets.

MULTIFUNCTIONAL COATED PRINTING SHEETS FOR USE IN ELECTROPHOTOGRAPHIC AND OFFSET PRINTERS

Background of the Invention

The present invention relates to a high quality coated printing sheet. More particularly, the present invention relates to multifunctional coated printing sheets for use in electrophotographic printers, i.e., monochromatic or color printers or copiers, and in conventional offset printing presses. The present invention further relates to a method of manufacturing such a multifunctional coated printing sheet.

Electrophotographic printing is one of the primary methods of electronic, or digital, monochromatic and color copying and printing. Electrophotographic printing may employ dry toner technology, i.e., xerography, or liquid toner technology. Electrophotographic printing generally includes seven steps to reproduce or print an image: (a) charging a photoreceptor; (b) exposing an image with a light source, e.g., a light emitting diode, a fluorescent light or a laser, on the surface of the photoreceptor to form a charged latent image on the surface; (c) developing the latent image with a toner of opposite charge; (d) transferring the charged toner image to a paper sheet, the sheet having a charge opposite to that of the toner; (e) fusing the toner to the sheet; (f) erasing the latent image from the photoreceptor; and (g) cleaning the residual toner from the photoreceptor. When the light source used in step (b) is a laser, the electrophotographic printer is referred to as a laser printer.

For sheetfed electrophotographic printers, a transport system is required to feed the sheet into the printer, to transport the sheet through the printer and to deliver the printed sheet to an output tray. Generally a feed belt, e.g., friction or vacuum belt, is used to pick up a sheet and feed it into a driven nip. The feed belt may be controlled by a timing mechanism in order to stop it momentarily to allow spacing between sheets. Once a sheet is picked up by the feed belt and the driven nip, it is transported through the rest of the printer via belts and drive wheels.

The nature of the transport system, and in particular the feeding mechanism, provides numerous opportunities for paper jams. Consequently, good runnability, i.e., minimal number of jams, of the sheet through the electrophotographic printer is desired. A jam in an electrophotographic printer is generally a mistiming event which encompasses a variety of problems, e.g., a misfeed, loss of traction during transport through the printer, or an actual physical jam of the paper in the printer, all of which may cause the electrophotographic printer to shut down. The primary cause of jams is typically a misfeed of the paper, e.g., double feeding, a physical jam, or slippage in the paper feed tray. Because most laser printers were designed to accommodate uncoated printing sheets, uncoated printing sheets tend to exhibit better runnability than coated printing sheets.

Increasingly, printers demand multifunctional coated sheets that will perform well both in electrophotographic printers and in offset printing presses. A coated printing sheet that provides the desired printed product attributes and performs well in both offset printing presses and electrophotographic printers allows printers to minimize paper inventories. In addition, such a coated printing sheet may be used for sequential printing. For instance, printed material for the print-on-demand market is often the result of a two stage process. First, the primary images, typically color images, and text are printed on conventional offset printing presses. Then the variable data, e.g., personalized information such as the recipient's name and address, are added by electrophotographic printers.

Coated printing papers designed for use in conventional offset printing presses tend to jam in electrophotographic printers. Good runnability is critical for large scale commercial electrophotographic printing operations because runnability directly affects productivity, e.g., downtime required to address jams, and cost, e.g., labor and equipment damage. There remains a need for a coated printing sheet that exhibits comparable runnability to that of an uncoated sheet, i.e., essentially jam-free performance, in electrophotographic printers.

Summary of the Invention

The inventor has discovered that if the image receptive coating of a coated printing sheet includes platy pigment, i.e., a pigment material in which the particle shape resembles a plate having a diameter that is much greater than its thickness, runnability in electrophotographic printers is adversely affected. The inventor has found that by substantially reducing the amount of platy pigment in the coating, a coated printing sheet may be provided which exhibits good runnability in electrophotographic printers, e.g., runnability comparable to that of an uncoated sheet. Without intending to be bound by any particular theory, this phenomenon appears to be related to contamination of the transport system in an electrophotographic printer by platy pigment material, which may cause slippage of the sheets during transport. Such slippage may lead to "out of sequence" timing which may cause the printer to shut down.

The present invention provides multifunctional coated printing sheets suitable for use in both electrophotographic printers and in conventional offset printing presses. The term "multifunctional coated printing sheet," as used herein, means a coated printing sheet that is suitable for use in electrophotographic printers and in conventional offset printing presses. Preferred multifunctional coated printing sheets of the invention provide runnability characteristics comparable to those of an uncoated printing sheet in most electrophotographic printers. The multifunctional coated printing sheets also exhibit the surface and optical properties, e.g., paper gloss, brightness, opacity and smoothness, required of conventional offset printing grades, and provide a surface that is image

receptive and resistant to coating failure or picking, i.e., localized delamination of the coating layer from the underlying substrate during toner fusing in electrophotographic printers or during ink transfer in offset printing. The invention further provides methods for manufacturing such multifunctional coated printing sheets.

In one aspect, the invention provides a multifunctional coated printing sheet including a substrate and, on at least a first surface of the substrate, an image receptive coating, wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

In another aspect, the invention provides a multifunctional coated printing sheet including a substrate and, on at least a first surface of the substrate, an image receptive coating including a binder and a non-platy pigment, wherein the coating includes 100 parts of pigment, of which 10 parts or less are a platy pigment, wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

In another aspect, the invention provides a multifunctional coated printing sheet including a substrate and, on at least a first surface of the substrate, an image receptive coating including a binder and a non-platy pigment, wherein the coating is substantially free of a platy pigment, wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

Preferred embodiments may include one or more of the following features. The substrate is paper. The multifunctional printing sheet provides the surface and optical properties required of conventional offset printing grades. The multifunctional printing sheet provides a surface that is image receptive and resistant to coating failure. The term "parts," as used herein, means dry parts based on 100 parts of pigment. The coating includes 100 parts of pigment, of which at least 75 parts are a non-platy pigment selected from the group consisting of natural ground calcium carbonate, precipitated calcium carbonate and mixtures thereof. Preferably at least 90 parts of the non-platy pigment is a pigment selected from the group consisting of precipitated calcium carbonate and mixtures of natural ground calcium carbonate and precipitated calcium carbonate. More preferably the non-platy pigment is a mixture of natural ground calcium carbonate and precipitated calcium carbonate, and the precipitated calcium carbonate component comprises at least 50% of the total mixture. The remainder of the pigment consists of non-platy pigments selected from the group consisting of calcined clays, structured clays, titanium dioxide, satin white, hollow sphere plastic pigments, solid plastic pigments, silicas and mixtures thereof. The coating includes about 6 to 20 parts of a binder, preferably about 9 to 15 parts. The binder includes a latex, selected from the group consisting of styrene butadiene, styrene butadiene acrylonitrile, styrene acrylic, styrene butadiene acrylic and mixtures thereof, and a water soluble or water miscible co-binder, selected from the

group consisting of starches, polyacrylate salts, polyvinyl alcohol, carboxymethyl cellulose, hydroxymethyl cellulose and mixtures thereof. Preferably the latex comprises at least 50% of the total binder, more preferably at least 75% of the total binder. Preferably the co-binder includes 3 parts or less of a starch. The substrate has an ash content of about 10 to 18%, preferably about 12 to 15%. The image receiving coating has a total dried coat weight of about 8 to 15 g/m^2, preferably about 10 to 12 g/m^2. The multifunctional coated printing sheet has a final moisture level of about 3.0 to 4.5%, preferably about 3.5 to 4.0%.

In another aspect, the invention provides a method of manufacturing a multifunctional coated printing sheet including:

a) applying an image receptive coating to at least a first surface of a substrate; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet provides runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

In another aspect, the invention provides a method of manufacturing a multifunctional coated printing sheet including:

a) applying an image receptive coating, comprising a binder and a non-platy pigment, to at least a first surface of a substrate, wherein the image receptive coating includes 100 parts of pigment, of which 10 parts or less are a platy pigment; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet provides runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

In another aspect, the invention provides a method of manufacturing a multifunctional coated printing sheet including:

a) applying an image receptive coating, comprising a binder and a non-platy pigment, to at least a first surface of a substrate, wherein the image receptive coating is substantially free of a platy pigment; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet provides runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

Preferred methods may include one or more of the following features. The multifunctional printing sheet provides the surface and optical properties required of conventional offset printing grades. The multifunctional printing sheet provides a surface that is image receptive and resistant to coating failure. A calendering step is performed after the drying step. The calendering step is performed by a soft nip calendering unit. Preferably the calendering step is performed by a soft nip on-line calender, at a nip pressure of about 175 to 440 kN/m, an operating roll temperature of about

150 to 250 °C, and an incoming web moisture of about 4 to 6%. Preferably the nip pressure is about 315 to 385 kN/m and the operating roll temperature is about 175 to 220 °C. The final product moisture of the multifunctional printing sheet after calendering is about 3.0 to 4.5%, preferably about 3.5 to 4.0%. A brushing step is performed before or after the calendering step, preferably after the calendering step. The net specific brushing intensity applied to the substrate during the brushing step is about 0.005 to 0.07 kW hr/m^2.

In another aspect, the invention provides a method of using a multifunctional coated printing sheet including:

a) printing a first image on the multifunctional printing sheet in an offset printing press; and

b) printing a second image on the multifunctional printing sheet in an electrophotographic printer, wherein the multifunctional printing sheet provides runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

Other features and advantages of the invention will be apparent from the following detailed description, the drawings, and the claims.

Detailed Description of Preferred Embodiments

The multifunctional coated printing sheets exhibit runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers, provide the surface and optical properties expected for conventional offset printing grades, and provide a surface that is image receptive and resistant to coating failure. The image receptive coating of the multifunctional printing sheets provides adequate toner adhesion, i.e., the printed images tend to be resistant to scratching and the toner typically does not flake off the coated surface at creases or folds made through image areas. The multifunctional coated printing sheets are suitable for offset printing, which typically requires a smooth and image receptive surface. Additional requirements pertaining to other product attributes are imposed by printers and the particular printing job, such as brightness, shade, opacity, and the gloss of the paper and of the printed image. Embodiments of the invention may satisfy the requirements of a premium, #1, #2 or #3 grade, as such grades are designated by the industry based on sheet brightness and aesthetic criteria such as paper surface quality and final printed image quality. The image receptive coating of the multifunctional coated printing sheets exhibits sufficient ink transfer, i.e., the absorption of the ink-fountain solution mixture by the surface is such that a uniform film of ink is transferred from the printing blanket to the sheet during offset printing, and sufficient ink holdout, i.e., the printing ink remains on the surface of the coating. Ink transfer and ink holdout affect final product attributes such as the ink gloss and sharpness of the printed image.

The multifunctional coated printing sheet comprises a substrate and, on at least a first surface of the substrate, an image receptive coating including a binder and a non-platy pigment. The

coating may further include 10 parts or less of a platy pigment, e.g., clay, kaolin, bentonite, alumina trihydrate or talc. Preferably the coating is substantially free of platy pigment.

Suitable non-platy pigments include ground calcium carbonates, precipitated calcium carbonates, calcined clays, structured clays, titanium dioxide, satin white, hollow or solid plastic pigments, silicas and mixtures thereof. Suitable non-platy pigments provide the optical properties required of offset printing grades, such as brightness and opacity. Suitable non-platy pigments enhance the surface coverage of the substrate by the coating layer as well as improve image receptivity of the coating. Practitioners skilled in the art are aware of how to select the appropriate non-platy pigments to achieve the desired final product attributes.

Preferably the coating comprises 100 parts of pigment, of which at least 75 parts, more preferably at least 90 parts, are a non-platy pigment, selected from the group consisting of natural ground calcium carbonate, precipitated calcium carbonate and mixtures thereof. It is most preferred that the non-platy pigment comprise a mixture of natural ground calcium carbonate and precipitated calcium carbonate, and that the precipitated calcium carbonate comprise at least 50% of the total mixture. A high proportion of precipitated calcium carbonate in the coating is preferred because such coatings tend to provide improved optical product attributes and to exhibit improved fiber coverage of the substrate. Improved fiber coverage permits the use of lower coat weights, resulting in a greater fiber-to-coating ratio for the sheet. A greater proportion of fiber in the sheet tends to increase the overall stiffness of the sheet. However, an excessively high proportion of precipitated calcium carbonate may negatively affect other desirable final product attributes such as paper gloss. Practitioners skilled in the art are aware of how to select the appropriate ratio of precipitated and ground calcium carbonate pigments in the coating to achieve desired final product attributes.

Calcium carbonates are commercially available in a broad range of surface areas, average particle sizes and particle size distributions. Precipitated calcium carbonates tend to have smaller surface areas than ground calcium carbonates. Typically, the surface area of the precipitated calcium carbonate ranges from about 8.0 to 12.0 m^2/g, and the surface area of the ground calcium carbonate ranges from about 10.0 to 16.0 m^2/g. Preferably the surface area of the precipitated calcium carbonate is about 9.0 to 10.0 m^2/g, and the surface area of the ground calcium carbonate is about 12.0 to 14.0 m^2/g.

Typically the equivalent spherical diameter (ESD) of the calcium carbonate particles is less than about 2 μm. Preferably, for glossy coated printing sheets, about 90 to 95% of the particles have an ESD of less than 2 μm. Preferably, for matte coated printing sheets, about 65% of the particles have an ESD of less than 2 μm. If the distribution of calcium carbonate particles is skewed to a larger particle size, the paper gloss may be affected deleteriously. If the distribution of calcium carbonate particles is skewed to an excessively small particle size, there is an increased tendency for

coating defects, e.g., blade scratches, during the application of the coating to the paper substrate. Practitioners skilled in the art are aware of how to select the appropriate particle size distribution to achieve the desired product attributes and to minimize coating defects.

Preferably, the calcium carbonate pigment will exhibit a relatively narrow particle size distribution. A narrow particle size distribution in the coating tends to improve fiber coverage and to enhance optical properties. If the particle size distribution is too narrow, the application of the coating to the substrate may be negatively affected, e.g., poor coat weight control and blade scratches due to poor water retention of the coating layer. If the particle size distribution is too broad, the particles exhibit more efficient packing within the coating layer which may lead to a more dense, less porous coating resulting in a deterioration of fiber coverage. Reduced porosity may also affect the ability of moisture within the printing sheet to escape during printing. When moisture cannot escape rapidly, blistering, i.e., disruptions in the printed image caused by the delamination of the coating layer from the underlying substrate, may result.

Suitable precipitated calcium carbonates are manufactured by J.M. Huber Corporation, Specialty Minerals, Inc. and Imerys Pigments, Inc. Suitable ground calcium carbonates are commercially available from Imerys Pigments, Inc. and Omya Incorporated.

Preferred calcium carbonates enhance the optical properties of the sheet, such as brightness, improve coating bulk, and improve toner adhesion in electrophotographic printers. A bulky coating typically has a more open pore structure which tends to enhance toner adhesion and to improve blister resistance. Preferably the ground calcium carbonates will exhibit a blocky, i.e., irregular spherical, shape. Precipitated calcium carbonates are commercially available in an array of particle shapes. Preferably the precipitated calcium carbonates will exhibit a rhombohedral shape.

Preferably, the image receptive coating includes plastic pigments, hollow sphere or solid. Suitable plastic pigments enhance the surface and optical properties of the image receptive coating, such as gloss, opacity, smoothness and bulk. Typically, the average particle size of solid plastic pigments ranges from 0.13 to 0.50 μm. Suitable solid sphere plastic pigments are commercially available from The Dow Chemical Company, e.g., Dow 722, and from Omnova Solutions, Inc., e.g., Lytron 2503. For hollow sphere plastic pigments, the average particle size typically ranges from about 0.5 to 1.0 μm with a shell thickness of about 0.06 to 0.09 μm. The hollow core diameter typically ranges from about 0.38 to 0.82 μm, resulting in void volumes of about 43% to 55%. Preferred hollow sphere plastic pigments have an average particle size of about 1.0 μm and a void volume of about 50% to 55%. Suitable hollow sphere plastic pigments are commercially available from Rohm and Haas Company, e.g., Ropaque HP-1055 and Ropaque HP-543P.

The binder component of the coating includes a coating latex. Preferably the amount of binder in the coating is about 6 to 20 parts, more preferably about 9 to 15 parts. The amount of

binder in the coating should provide adequate coating strength to resist picking, i.e., localized delamination of the coating layer from the underlying substrate, during the manufacturing process and during printing. Typical monomers used in the production of latex polymers for paper coatings include styrene, butadiene, acrylonitrile, butyl-acrylate, methyl methacrylate, vinyl acrylic, isoprene and combinations thereof. Preferred latexes permit the use of a coating with high solids level while maintaining acceptable viscosity. Preferred latexes also provide aesthetically desirable surface qualities to the final coated printing sheet, such as gloss, brightness and smoothness. Preferred latexes include styrene butadiene, styrene butadiene acrylonitrile, styrene acrylic, styrene butadiene acrylic and mixtures thereof. Preferably the glass transition temperature of the latex, Tg, falls within the range of 5 to 25°C. If the Tg is too low, the latex when dry tends to be tacky which affects the tackiness of the dried coating, e.g., the dried coating layer may stick to further processing rolls, thereby decreasing the final gloss of the sheet. If the Tg is too high, the latex when dry tends to resist molding which provides a high final gloss but reduces the coating strength.

The mean particle size of the latex particles, for glossy coated printed sheets, is typically about 1600 to 2000 angstroms, preferably about 1800 angstroms. The mean particle size of the latex particles, for matte coated printed sheets, is typically about 1000 to 1400 angstroms, preferably about 1200 angstroms. Coatings with smaller latex particles typically exhibit improved coating strength because smaller particles provide a greater surface area per unit weight with which to bind the other coating components. Improved coating strength tends to reduce the occurrence of picking in the offset printing press. Examples of suitable latexes include: Dow 620NA, Dow 640NA, and Dow 615, manufactured by The Dow Chemical Company; Gen-Flo 5086, Gen-Flo 8045, and GenCryl 9710, manufactured by Omnova Solutions Inc.; and Acronal S504, Acronal S728, and Styronal 4664 manufactured by BASF Corporation.

The binder component of the coating may further include a water-soluble or water-miscible co-binder, selected from the group consisting of a starch, polyacrylate salt, polyvinyl alcohol, carboxymethyl cellulose, hydroxymethyl cellulose and mixtures thereof. Suitable starches include pearl, ethylated, oxidized or enzyme treated starch, all of which may be derived from potato, corn, rice or tapioca starches. Co-binders are typically used to manipulate coating rheology and water retention of the coating. Preferably the amount of starch in the co-binder is about 3 parts or less. If more than about 3 parts of starch is used in the co-binder, the brightness and gloss of the coating may be substantially reduced and a lower coating solids is often required which deleteriously affects fiber coverage. Preferably the latex component of the binder comprises the greater proportion, e.g., at least 50%, more preferably at least 75% of the total weight of binder. Practitioners skilled in the art are aware of how to select the appropriate binder and co-binder package to achieve the desired coating rheology.

The coating may further include optical-related coating additives, such as colorants, tinting dyes, fluorescent brighteners, blooming agents and mixtures thereof. Practitioners skilled in the art are aware of how to select the appropriate optical package to achieve the desired final product attributes, such as shade and brightness.

The coating may further include coating additives, such as dispersants, thickeners, defoamers, water retention agents, preservatives, crosslinkers, lubricants and pH control agents. Practitioners skilled in the art are aware of how to select the appropriate coating additives to meet manufacturing and production objectives, e.g., to control foam, rheology, dusting, calender releasability, and to achieve the desired final product attributes.

The substrate is preferably a paper substrate of a weight and type suitable for offset printing. The basis weight of suitable substrates typically ranges from about 65 to 325 g/m^2, preferably about 65 to 216 g/m^2. Preferably the ash content of the substrate, i.e., the amount of inorganic material incorporated within the substrate, including virgin pigment material and pigment material derived from a recycled fiber component of the substrate, is about 10 to 18%, more preferably about 12 to 15%. If the ash content of the substrate is too high, the stiffness of the substrate may decrease significantly. If the ash content is too low, the optical properties, e.g., opacity and brightness, of the sheet may be adversely affected, and the cost of production may increase.

The substrate may further include a precoat or a base coat layer. A precoat layer may enhance the surface strength of the coating layer, e.g., to resist picking, increase coating holdout (i.e., the ability of the coating to remain on the surface of the substrate rather than striking into the substrate), and improve optical properties of the final printing sheet, such as gloss, opacity and brightness. Practitioners skilled in the art are aware of how to select the appropriate precoat or base coat formulation to achieve the desired balance of surface strength, coating holdout and final optical properties. If both sides of the substrate are coated with the image receiving coating layer, the formulation of the precoat or base coat is unrestricted. If only one side of the substrate is coated, preferably the other side does not include a precoat or base coat, or the precoat or base coat does not contain any platy material.

The image receptive coating is applied to the substrate using an on-machine or off-machine coater. Examples of suitable coating techniques include an applicator means, e.g., applicator roll, fountain, jet, slotted die, and curtain, and/or a metering means, e.g., bent blade, bevel blade, rod, roll, short dwell, air knife, bar, gravure, size press (conventional or metering), and air brush. Preferably, the coating layer is applied by a bent blade/applicator roll coater. The coating may be applied in one or more layers. Preferably the total coat weight applied per side is about 8 to 15 g/m^2, more preferably about 10 to 12 g/m^2. The solids level of the coating will typically range from about 55 to 70%; a coating with a lower solids is typically used when the coating is applied in more than one

layer. Preferably the coating is applied to both sides of the substrate to ensure that the printed images on both sides of the printing sheet are of comparable quality. The coating layer is then dried, e.g., by convection, conduction, infrared, or combinations thereof.

A calendering step may be performed after the substrate has been coated and dried. The calendering apparatus may be a separate supercalender, an off-line soft nip calender, or an on-line soft nip calendering unit. The level of calendering performed on the sheet is dependent on the desired product attributes, such as paper gloss and sheet bulk. Suitable supercalenders consist of alternating steel and non-metal rolls, e.g., cotton, cotton-wool or plastic shell, creating about 9 to 13 nips. Suitable soft nip calenders, on-line or off-line, consist of pairs of rolls, each pair including a heated metal roll against a compliant plastic composite roll, creating 2 to 8 nips, preferably 4 nips. For glossy coated paper, typical supercalender process conditions include a bottom nip pressure range of 175 to 440 kN/m, steel roll temperatures of about 65 to 95 °C, and an incoming web moisture of about 4 to 6%. For glossy coated paper soft nip calendered, preferably the nip pressures range from about 175 to 440 kN/m, the operating roll temperature ranges from about 150 to 250 °C, and the incoming web moisture is about 4 to 6%. More preferably the coated printing sheet is soft nip calendered on-line, with a nip pressure of 315 to 385 kN/m, and an operating roll temperature of about 175 to 220 °C. For matte coated printing paper, lower nip pressures, lower operating roll temperatures and fewer nips are typically used, for both supercalendering and soft nip calendering. Preferably the final product moisture of the printing sheet after the calendering step ranges from about 3.0 to 4.5%, more preferably 3.5 to 4.0%. Practitioners skilled in the art are aware of how to select the appropriate calendering conditions, e.g., web speed, web moisture, nip pressure and calendering temperature, to achieve the desired final product attributes.

A brushing step may be performed after the substrate has been coated and dried. Preferably the brushing step is performed before or after the calendering step, more preferably after the calendering step. The brusher apparatus may be a separate apparatus, or a process unit in a continuous line. Brushing may be used to achieve the desired levels of paper gloss and smoothness at a higher bulk than may be achieved through calendering alone. Brushing intensity is controlled by three variables: brushing area, i.e., the surface area of the coated substrate in contact with the brushes; brushing force, i.e., the tangential force applied by the brushes against the surface of the coated substrate; and brush speed. Net specific brushing intensity is calculated from the net power of the brusher motor, the substrate web speed, and the width of the substrate web. Preferably the net specific brushing intensity applied to the substrate is about 0.002 to 0.1 kW hr/m^2, more preferably about 0.005 to 0.07 kW hr/m^2. If the brushing intensity is too low, the desired level of gloss and smoothness may not be achieved. If the brushing intensity is too high, the surface of the image receiving layer may be damaged, e.g., scratches and streaks, and undesirable dusting may occur.

Suitable brushers typically have a plurality of brush rolls, e.g., four to eight brush rolls, and are commercially available from DOX Maschinenbau GmbH.

The coated printing sheet of the invention may be printed on one or both surfaces of the substrate. The coated printing sheet of the invention may be printed in an offset printing press, in an electrophotographic printer or both. Because both offset printing presses and electrophotographic printers are available in web or sheetfed models, the coated printing sheet may be supplied in web form or in sheet form.

Sequential printing typically requires a multifunctional printing sheet. Generally the printing sheet is (a) printed in an offset printer, (b) cut into a size acceptable for electrophotographic printers, and (c) printed in an electrophotographic printer, e.g., monochromatic and/or color printers. If a web offset printer and a web electrophotographic printer are available, a cutting step between the printing steps is unnecessary. For sheetfed offset printing, the multifunctional coated printing sheet is generally supplied in large sheet form. After offset printing, the large sheets are cut to the appropriate size by a guillotine cutter and printed in an electrophotographic printer. For web offset printing, the multifunctional coated printing sheet is supplied as a roll of paper. After offset printing, the printed web of paper is cut to the appropriate size in a sheeter and printed in an electrophotographic printer. When offset printed and cut sheets are printed in electrophotographic printer, it is generally important to minimize contamination, e.g., dirt, dried coating debris and loose fibers, from the various sheeting processes, e.g., cutting before or after offset printing, which may affect runnability in the electrophotographic printers. When web models of both the offset printer and the electrophotographic printer are used, no sheeting occurs until the printing is completed.

Color electrophotographic sheetfed printers often have two printing speed settings; a high speed setting typically used for uncoated sheets and a low speed setting typically used for heavier or coated sheets. Regardless of the speed setting, complete toner fusing of the toner to the image receptive coating is particularly important for color electrophotographic printing. If toner fusing is inadequate, the quality of the printed images may be adversely affected, e.g., the images may exhibit mottle, unprinted areas, picking in image areas, and low toner gloss. Another problem that may arise during printing in color electrophotographic printers is blistering. The multifunctional coated printing paper of the invention provides an acceptable image receptive surface without blistering at both the low and high speed settings in a color electrophotographic printer.

Examples

Table 1 below provides coating formulations and final product attribute data for four embodiments of the invention. In each case, the paper was soft nip calendered on-line under the following conditions: a nip pressure of 175 kN/m; a temperature of about 218 °C for the heating

medium in the heated rolls; 4 nips total; and a web speed of about 610 m/min. The substrate for Example A was manufactured on a different papermachine, which may have caused some differences in product attributes typically affected by substrate differences.

Table 1

	Example A	Example B	Example C	Example D
Formulation:				
Ground Calcium Carbonate	15	15	15	15
Precipitated Calcium Carbonate	77	79	77	75
Hollow Sphere Plastic Pigment	8	6	8	10
Latex	8.5	9.5	9.5	9.5
Co-binder	3.6	1.6	1.6	1.6
Process Conditions:				
Ave Coat Weight per side (g/m^2)	13.3	13.5	13.6	13.5
Final Moisture (%)	3.5	4.1	4.0	4.0
Product Attributes:				
Tobias Microgloss	633	314	285	266
Opacity	96.0	94.0	95.0	95.6
Brightness	91	90	93	91
75° Gloss	67	69	73	76
75° Ink Gloss	94	95	96	97
60° Toner Gloss ($1^{st}/10^{th}$)[1]	61.7/38.4	48.9/25.5	63.2/42.0	44.2/26.1
PPS 10 kg Soft	1.05	0.97	0.80	0.77
L&W Stiffness (MD/CD)[2]	40.4/22.9	31.2/15.8	31.0/18.7	38.8/21.3

Note: 1. Toner gloss for the first and tenth sheets printed.
2. Bending force in mN.

Tobias Microgloss is a measure of the point-to-point variation in gloss, using a 1.5 mm microgloss head in the Tobias Mottle tester. The lower the value, the more uniform is the surface gloss. Opacity and brightness measurements were performed according to Tappi Methods T-425 and T-452 om-87, respectively. The measurements for 75° gloss were performed on unprinted paper. The measurements for 75° ink gloss were performed on a single color ink (magenta) solid image, which was printed on a Vandercook proofing printing press and air-dried. Both the 75° gloss and 75° ink gloss measurements were performed according to Tappi Method T-480. The measurements for the 60° toner gloss were performed using a BYK Gardner Micro-TRI-Gloss meter on a single color black image printed at the high speed setting on a DocuColor 40 color electrophotographic printer

manufactured by Xerox Corporation. A glossier unprinted paper surface is indicated by a higher 75° gloss value. For toner and ink glosses, the higher the value, the greater is the toner or ink gloss of the printed image. Parker Print Surface (PPS) is a measure of the smoothness of the surface, with a lower value indicating a smoother surface. PPS measurements were performed according to Tappi Method T-555om-94. The measurements for Lorentzen & Wettre (L&W) stiffness were performed according to method DIN-53-1221. L&W stiffness is the bending force which results when a sample is subjected to a bending angle of 15°, and a higher value indicates greater stiffness.

Except for toner gloss and stiffness, which tend to be more important for electrophotographic printing, the product attributes provided in Table 1 are typically used to differentiate between coated printing sheets for offset printing. Generally, glossy coated printing papers suitable for offset printing exhibit brightness greater than about 82.0, 75° gloss greater than about 65.0, 75° ink gloss greater than about 90.0, and PPS smoothness less than about 1.20. Matte coated printing papers suitable for offset printing typically exhibit brightness greater than about 82.0, 75° gloss equal to or less than about 50.0, 75° ink gloss greater than about 50.0, and PPS smoothness less than about 4.0.

The data in Table 1 demonstrates that the multifunctional coated printing sheets of the invention would be considered suitable for offset printing. The smoothness data is particularly notable because this data indicates that the coated printing sheets of the invention are very smooth, as required for offset printing. Contrary to expectations, such magnitude of smoothness does not adversely affect runnability in electrophotographic printers for the multifunctional coated printing sheets of the invention. Surface roughness is typically considered necessary for acceptable runnability in electrophotographic printers. The toner gloss data is also noteworthy because the samples were printed at the high speed setting, typically the most demanding printing condition. Although the toner gloss decreases initially during a print job, the level of toner gloss would be considered acceptable. Furthermore, blistering did not occur during printing in the color electrophotographic printer.

Coated printing paper of the invention, coated with the formulation for Example C described in Table 1, was evaluated on a high speed monochromatic electrophotographic printer, e.g., DocuTech 135 printer manufactured by Xerox Corporation. The DocuTech 135 offers two feeding mechanisms, the friction retard and the vacuum-assisted mechanisms. The examples listed in Table 2 were evaluated using the friction retard system, which tends to exhibit a greater propensity for jams with uncoated paper. The coated printing paper of the invention is Example E. Runnability results for comparative examples F and G, which were evaluated at the same time and on the same equipment, are also provided. Example F is a commercially available uncoated paper and Example G is a commercially available coated paper manufactured by S.D. Warren Company, which includes

more than 10 parts of a platy pigment in the coating. The table shows the number of sheets that were attempted to be printed, the number of sheets that were successfully printed, and the number of jams. In all cases, unprinted paper was evaluated. It is expected that jam rates would be different for previously printed sheets because the printing inks would affect the characteristics of the sheet.

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Table 2

	Example E	Example F	Example G
Sheets Attempted	5000	1000	10,000
Sheets Printed	5000	1000	7,000
Number of Jams	0	0	11

Because Example G had numerous jams, more attempts were made to run successfully. However, after 7000 sheets, the run was aborted because of the high number of jams and concerns about
10 potential equipment damage. The runnability data indicates that the coated printing sheet of the invention, which contains no platy pigment material, has comparable runnability to that of uncoated sheets.

Other embodiments are within the claims. For instance, the coated printing sheets of the invention are suitable for use in flexographic printing presses. Various modifications of this
15 invention will become apparent to those skilled in the art without departing from the scope or spirit of this invention.

What is claimed is:

CLAIMS

1. A multifunctional coated printing sheet comprising a substrate and, on at least a first surface of the substrate, an image receptive coating, wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

2. A multifunctional coated printing sheet comprising a substrate and, on at least a first surface of the substrate, an image receptive coating comprising a binder and a non-platy pigment, wherein the coating comprises 100 parts of pigment, of which 10 parts or less are a platy pigment, and the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

3. A multifunctional coated printing sheet comprising a substrate and, on at least a first surface of the substrate, an image receptive coating comprising a binder and a non-platy pigment, wherein the image receptive coating is substantially free of a platy pigment, and the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

4. The multifunctional coated printing sheet of claim 2 or 3 wherein at least 75 parts of said non-platy pigment is a pigment selected from the group consisting of natural ground calcium carbonate, precipitated calcium carbonate and mixtures thereof.

5. The multifunctional coated printing sheet of claim 4 wherein at least 90 parts of said non-platy pigment is a pigment selected from the group consisting of precipitated calcium carbonate and mixtures of natural ground calcium carbonate and precipitated calcium carbonate.

6. The multifunctional coated printing sheet of claim 5 wherein the non-platy pigment comprises a mixture of natural ground calcium carbonate and precipitated calcium carbonate, and the precipitated calcium carbonate comprises at least 50% of the mixture.

7. The multifunctional coated printing sheet of claim 4 wherein the image receptive coating comprises a second non-platy pigment selected from the group consisting of calcined clay, structured clay, titanium dioxide, satin white, hollow sphere plastic pigment, solid plastic pigment, silica and mixtures thereof.

8. The multifunctional coated printing sheet of claim 2 or 3 wherein the image receptive coating comprises about 6 to 20 parts of said binder.

9. The multifunctional coated printing sheet of claim 8 wherein the image receptive coating comprises about 9 to 15 parts of said binder.

10. The multifunctional coated printing sheet of claim 9 wherein the binder comprises a latex and a water soluble or water miscible co-binder.

11. The multifunctional coated printing sheet of claim 10 wherein the latex comprises at least 50% of the total binder.

12. The multifunctional coated printing sheet of claim 11 wherein the latex comprises at least 75% of the total binder.

13. The multifunctional coated printing sheet of claim 12 wherein the latex is selected from the group consisting of styrene butadiene, styrene butadiene acrylonitrile, styrene acrylic, styrene butadiene acrylic and mixtures thereof.

14. The multifunctional coated printing sheet of claim 10 wherein said co-binder is selected from the group consisting of a starch, a polyacrylate salt, polyvinyl alcohol, carboxymethyl cellulose, hydroxymethyl cellulose and mixtures thereof.

15. The multifunctional coated printing sheet of claim 14 wherein said co-binder comprises 3 parts or less of a starch.

16. The multifunctional coated printing sheet of claim 2 or 3 wherein the substrate has an ash content of about 10 to 18%.

17. The multifunctional coated printing sheet of claim 16 wherein the substrate has an ash content of about 12 to 15%.

18. The multifunctional coated printing sheet of claim 1, 2 or 3 wherein the image receptive coating has a total dried coat weight per side of about 8 to 15 g/m^2.

19. The multifunctional coated printing sheet of claim 18 wherein the image receptive coating has a total dried coat weight per side of about 10 to 12 g/m^2.

20. The multifunctional coated printing sheet of claim 1, 2 or 3 wherein the multifunctional printing sheet has a final product moisture of about 3.0 to 4.5%.

21. The multifunctional coated printing sheet of claim 20 wherein the multifunctional printing sheet has a final product moisture of about 3.5 to 4.0%.

22. The multifunctional coated printing sheet of claim 1, 2 or 3 wherein the multifunctional printing sheet provides surface and optical properties required of conventional offset printing grades.

23. The multifunctional coated printing sheet of claim 22 wherein the multifunctional printing sheet further provides a surface that is image receptive and resistant to coating failure.

24. A method of manufacturing a multifunctional coated printing sheet comprising:

a) applying an image receptive coating to at least a first surface of a substrate; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

25. A method of manufacturing a multifunctional coated printing sheet comprising:

a) applying an image receptive coating, comprising a binder and a non-platy pigment, to at least a first surface of a substrate, wherein the image receptive coating comprises 100 parts of pigment, of which 10 parts or less are a platy pigment; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

26. A method of manufacturing a multifunctional coated printing sheet comprising:

a) applying an image receptive coating, comprising a binder and a non-platy pigment, to at least a first surface of a substrate, wherein the image receptive coating is substantially free of a platy pigment; and

b) drying the image receptive coating layer,

wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

27. The method of claim 24, 25 or 26 wherein a calendering step is performed after the drying step.

28. The method of claim 27 wherein the calendering step is performed by a soft nip on-line machine calendering unit.

29. The method of claim 28 wherein the calendering step is performed at a nip pressure of about 175 to 440 kN/m, and an operating roll temperature of about 150 to 250 °C and an incoming web moisture of about 4 to 6%.

30. The method of claim 29 wherein the nip pressure is about 315 to 385 kN/m and the operating roll temperature is about 175 to 220 °C.

31. The method of claim 30 wherein a final product moisture of the multifunctional printing sheet after the calendering step is about 3.0 to 4.5%.

32. The method of claim 31 wherein the final product moisture of the multifunctional printing sheet after the calendering step is about 3.5 to 4.0%.

33. The method of claim 27 wherein a brushing step is performed after the calendering step.

34. The method of claim 33 wherein a net specific brushing intensity of about 0.005 to 0.07 kW hr/m^2 is applied during the brushing step.

35. The method of claim 25 or 26 wherein at least 75 parts of said non-platy pigment is a pigment selected from the group consisting of natural ground calcium carbonate, precipitated calcium carbonate and mixtures thereof.

36. The method of claim 35 at least 90 parts of said non-platy pigment is a pigment selected from the group consisting of precipitated calcium carbonate and mixtures of natural ground calcium carbonate and precipitated calcium carbonate.

37. The method of claim 36 wherein the non-platy pigment comprises a mixture of natural ground calcium carbonate and precipitated calcium carbonate, and the precipitated calcium carbonate comprises at least 50% of the mixture.

38. The method of claim 35 wherein the image receptive coating further comprises a second non-platy pigment selected from the group consisting of calcined clay, structured clay, titanium dioxide, satin white, hollow sphere plastic pigment, solid plastic pigment, silica and mixtures thereof.

39. The method of claim 25 or 26 wherein the image receptive coating comprises about 6 to 20 parts of said binder.

40. The method of claim 39 wherein the image receptive coating comprises about 9 to 15 parts of said binder.

41. The method of claim 24, 25 or 26 wherein the image receptive coating has a total dried coat weight per side of about 8 to 15 g/m^2.

42. The method of claim 41 wherein the image receptive coating has a total dried coat weight per side of about 10 to 12 g/m^2.

43. The method of claim 24, 25 or 26 wherein the multifunctional printing sheet provides surface and optical properties required of conventional offset printing grades.

44. The method of claim 43 wherein the multifunctional printing sheet further provides a surface that is image receptive and resistant to coating failure.

45. A method of using a multifunctional coated printing sheet comprising:

a) printing a first image on the multifunctional printing sheet in an offset printing press; and

b) printing a second image on the multifunctional printing sheet in an electrophotographic printer,

wherein the multifunctional printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers.

46. The method of claim 45 wherein the multifunctional printing sheet comprises a substrate and, on at least a first surface of the substrate, an image receptive coating comprising a binder and a non-platy pigment, wherein the image receptive coating comprises 100 parts of pigment, of which 10 parts or less are a platy pigment.

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47. The method of claim 45 wherein the multifunctional printing sheet comprises a substrate and, on at least a first surface of the substrate, an image receptive coating comprising a binder and a non-platy pigment, wherein the image receptive coating is substantially free of a platy pigment.

INTERNATIONAL SEARCH REPORT

Ir..t nal Application No
PCT/US 01/01521

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G03G7/00 B41M5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G03G B41M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 778 711 A (OTA MASAO ET AL) 18 October 1988 (1988-10-18) column 7 -column 8; example 1 column 8; example 5 --- -/--	1-4, 8-10, 16-19, 22-27, 35,36, 39-47

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 April 2001	23. 05. 2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vogt, C

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int ›nal Application No
PCT/US 01/01521

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 718 700 A (FUJI XEROX CO LTD ;NEW OJI PAPER CO LTD (JP)) 26 June 1996 (1996-06-26) abstract page 5, line 5 - line 10 page 5, line 37 page 7; example 2	1-4, 7-10,13, 18,19, 22-27, 35,36, 38,39, 41-47
X	EP 0 711 672 A (JUJO PAPER CO LTD) 15 May 1996 (1996-05-15) page 5 -page 7; examples 1-5; tables 1,2	1-4, 7-13,18, 22-27, 35-41, 43-47
X	EP 0 621 510 A (JUJO PAPER CO LTD) 26 October 1994 (1994-10-26) page 7; example 1	1-6, 8-13, 22-26, 35-37, 39,40, 43-46
X	US 5 643 631 A (DONIGIAN DOUGLAS WARD ET AL) 1 July 1997 (1997-07-01) column 3, line 42 - line 44 claim 1; table 1	1-4, 8-10,14, 22-26, 35,36, 39,43-47
P,X	WO 00 04231 A (ECC INT LTD) 27 January 2000 (2000-01-27) claims 1,7-9	1-5, 22-26, 43-47

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

tional application No.
PCT/US 01/01521

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1- 3, 22-26, 43-45 (all partial)
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 1- 3, 22-26, 43-45 (all partial)

Present claims 1 to 3, 22 to 26, 43 to 45 relate to multifunctional coated printing sheets or a method of manufacturing said multifunctional coated printing sheet or a method of using said multifunctional coated printing sheet by the reference to a desirable characteristic or property, namely:

"wherein the printing sheet exhibits runnability characteristics comparable to those of an uncoated printing sheet in electrophotographic printers".

Dependent claims 22, 23 and 43 and 44 further relate to a multifunctional coated printing sheet as defined in present claim 1, 2 or 3 or to a method of manufacturing said sheet further specify the following desirable characteristic or property:

"wherein the ... sheet provides surface and optical properties required of conventional offset prinitng grades" and
"wherein the ... sheet provides a surface that is image receptive and resistant to coating failure".

The claims cover all sheets and method of manufacturing and methods of using said sheets having this characteristic or property, whereas the application provides support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT for only a very limited number of such sheets and methods. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Independent of the above reasoning, the claims also lack clarity (Article 6 PCT). An attempt is made to define the sheet and method by reference to a result to be achieved.
Again, this lack of clarity in the present case is such as to render a meaningful search over the whole of the claimed scope impossible. Consequently, the search has been carried out for those parts of the claims which appear to be clear, supported and disclosed, namely those parts relating to the sheets and methods according to the Examples A to D as exemplify in the description, table 1 at page 12.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int[illegible]nal Application No
PCT/US 01/01521

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